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Estimation of Conversion Rates into Annuities: A Brazilian Perspective

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Abstract

Because pension plans have been marketed with outdated technical premises, Brazilian insurance companies find themselves required to identify additional resources to ensure their ability to meet future benefit payments obligations. When calculating the additional amount of this provision, the parameters used are: mortality and disability decrements, the structure of interest rates, financial performance, cancellation fees and conversion rates. The aim of this study is to present new techniques for the estimation of conversion rates. The resulting analysis of the data allows us to conclude that two factors—the volume of accumulated reserves and the classification of prices as actuarially fair—increase the propensity of an individual to convert resources in retirement. In turn, retirement age and the need for liquidity reduce the propensity to convert resources in retirement.

Keywords: Retirement, Annuity, Provision for Insufficient Contributions.

1. Introduction

Since the advent of commercialized private complementary pension plans in Brazil between the 1970s and 1980s, pension institutions have been obliged to define a number of factors at the time of product approval. First, they must define the technical premises of the mortality table and the interest rate that will be used at the time of retirement to determine the benefit value or the income paid to the individual contingent upon survival of the participant. Second, they must define the value of the provision, to be shown on the insurer's balance sheet as the present value of future obligations corresponding to the established benefit.

However, since mid-2010, it has become possible to approve products with dynamic tables, so that the definition of the mortality table used for benefit calculation occurs only on the participant's retirement date. Prior to this, there would be no change to the guarantees for the benefits payment phase. In other words, the technical premises used for the original calculation of the benefit and the provision of benefits did not change from those defined when the contract was made years, sometimes even decades, before the date of retirement.

Failure to use premises that reflected real expectations of mortality, interest and conversion rates (the entrant may or may not convert the cumulative balance into income) at the time of retirement resulted in an inadequate calculation of benefits to be paid to the participant during their lifetime. This meant that the resources accumulated by the participant could end up being insufficient to secure future obligations towards benefit payments.

In 2002, the Superintendent of Private Insurance (SUSEP), the governmental regulatory body of the Brazilian insurance, annuity and open complementary pensions industry, created a new provision for the balance sheets of regulated companies. This provision would complement the calculated provisions of benefits both past and future, and thus assure sufficient funds for payment of contracted benefits.

The model for calculating the provision for insufficient contributions (PIC) allows for the use of various parameters, including conversion rate into income. The percentage that will be converted into income is not known in advance, because conversion is the prerogative of the participant; it is his or her decision whether to convert all, part or none of the benefit into income. Table 1 shows the influence of the conversion rate on the measurement of PIC.

Table 1 - Conversion Rate Sensitivity (in R$ millions)

Accumulated Amount	Conversion Rate	Amount Covered	PIC Factor	Estimated PIC
3,000	100%	3,000	25%	750.0
3,000	75%	2,250	25%	562.5
3,000	50%	1,500	25%	375.0
3,000	25%	0,750	25%	187.5
3,000	0%	0,000	25%	0.0

Source: Developed by the authors.
Table 1 shows the PIC values for a theoretical portfolio with accumulated resources in retirement (accumulated amount) of R$3 billion for five assumed conversion rates (from 0% to 100%). The PIC factor represents the insufficiency of reserves as a percentage of the accumulated amount.

This work aims to present a new method for estimating conversion rates (and therefore, also PIC) by using statistical techniques to study the behavior of individuals faced with the decision of whether to convert accumulated resources into actuarial annuities.

The paper is organized as follows: Chapter 2 contains a review of the literature on the subject. Chapter 3 provides an explanation of the statistical techniques used to study the behavior of individuals and it also discusses the data. An analysis of the results is presented in Chapter 4 and, finally, conclusions drawn from the study are discussed in Chapter 5.

2. Literature Review

The literature on annuity conversions is extensive (Yaari, 1965; Milevsky and Young, 2002; Dus et. al., 2005, Purcal and & Piggot, 2008) and usually attempts to explain the reasons behind the low level of conversion observed worldwide in the field of open complementary pensions. There are five main reasons described in the subject literature: the presence of a bequest motive, or the desire to leave an inheritance to descendants; the existence of a social security system that covers the minimum costs for the needs of older people; the irreversibility of the decision to convert; lack of liquidity; and the offer of annuities at actuarially unfair prices.

Yaari (1965) was one of the first authors to analyze conversion with a microeconomic model. In his study, the author concludes that the decision whether or not to convert accumulated savings into a lifetime annuity is affected by the desire to transfer wealth to descendants. A series of subsequent studies sought to measure this effect and results range from a strong influence (Bernheim, 1991; Purcal and Piggot, 2008), to a negligible influence (Melia and García, 2006; Horneff et. al., 2010).

Milevsky and Young (2002) introduced a real options utility to identify the factors that encourage investors to delay the annuitization of their accumulated wealth. The authors demonstrate that the real option value depends on the consumer's private information, particularly their expectation of survival (based upon the condition and history of their health) and their degree of risk aversion. Milevsky and Young's conclusion is that many of the results presented in previous studies on the benefits of annuitization disregarded the irreversibility of the decision and the possibility that the structure of interest rate terms could change significantly over time. The healthier and more risk-tolerant the individuals, the greater the value of the option of postponing conversion. In other words, delaying the annuitization can bring opportunities for financial gain and increasing wealth. Individuals with impaired health also tend to delay annuitization. This delay is probably because a portion of the accumulated wealth would never be realized; the insurer would retain it. Conversion, then, appears suitable only for those individuals with significant risk aversion and good health. In other words, the higher the risk aversion, the greater the desire to transform accumulated wealth into income.

In the same vein, Davidoff, Brown and Diamond (2005) show that the combination of a lack of liquidity of lifetime incomes and an incomplete annuity market gives rise to an optimal solution characterized by a partial conversion of savings.

Dus, Maurer and Mitchell (2005) tested a series of combinations between the option to convert into income and the option of programmed withdrawals (partial consumption of the accumulated amount). The results indicate that for neutral individuals or risk-takers, where technical premises of mortality reflect their reality, a programmed withdrawal option (self-annuitization) is more appealing, in part because of the flexibility offered by this payment method (it can be designed according to the needs of each person, at any point in his or her life). The authors also highlight how the high costs charged by pension institutions create annuities offered at actuarially unfair prices and thus a negative effect on the conversion rate.

Purcal and Piggot (2008) studied the reasons for the low demand for voluntary annuities in Japan and, as done in previous studies, modeled the problem using the theory of utility maximization for the individual throughout his life. They considered the trade-off between annuities versus life insurance, to minimize the effect of the bequest motive. Even though it is still possible to leave a reasonable amount to beneficiaries through a life insurance policy in the event of death, the authors believe the presence of the bequest motive is the main explanation behind the low level of conversion, followed by the retirement pension granted by Japan's social security (which absorbs most of the demand for annuities)

and the high fees charged by the companies selling these products. These fees take into account not only longevity risk, but also anti-selection or adverse-selection risk (acquisition of income by individuals with an above-average likelihood of loss in greater proportion to individuals with a below-average likelihood of loss).

3. Methodology

As the response variable analyzed in the problem has binary nature (to convert, versus not to convert), models from the limited dependent variable family were evaluated. From these models, Probit and Logit were selected. For the purposes of this paper, the Probit model is used to determine the propensity of an individual to convert into income, given a set of characteristics present at the time of retirement. The Logit model presents the marginal effects of the variables considered in the model.

According to Wooldridge (2006) and Heij et al. (2004), Probit and Logit models have the following specification:

$$P(y = 1|x) = G(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k).$$

In the Probit model, G is the normal cumulative standard distribution function, expressed by the integral:

$$G(z) = \Phi(z) = \int_{-\infty}^{z} \emptyset(v)dv \ ,$$

where $\emptyset(z)$ is the normal standard density:

$$\emptyset(z) = (2\pi)^{-1/2}\exp\left(\frac{-z^2}{2}\right).$$

In the Logit model, G is the cumulative distribution function of a random logistical standard variable, expressed by:

$$G(z) = \exp(z)/[1 + \exp(z)].$$

Evaluation of the model can be achieved by a model fit measure, global correctly predicted percentage, which is obtained by comparing the number of times predicted y equals real y, weighted by the fractions of zeros and ones in the sample. To calculate this model fit, it is assumed that if $G(.) > c,\ then\ y_i = 1\ and\ if\ G(.) \leq c,\ then\ y_i = 0,$ where c is a constant between 0 and 1 chosen arbitrarily. For the purpose of this study, the decision to convert is deemed success (y = 1), and the decision not to convert is deemed failure (y = 0).

The features present in the G function include the reasons for conversion presented in the literature review plus a "year" variable, identifying the point in time at which the decision to convert or not convert was taken. The year variable attempts to capture the aggregated temporal effects. Additionally, the G function includes a “sex” dummy variable, which seeks to identify if there is change in behavior because of gender.

Therefore, the summarized specification of the Probit and Logit models adapted to the problem in question is:

$$P(y = 1|x) = G(\beta_0 + \beta_1 bequest\_motive + \beta_2 decision\_irreversability + \\ + \beta_3 liquid\_necessity + \beta_4 price\_classification + \beta_5 sex + \beta_6 year)$$

Information available in the data is used as proxies for these variables, as follows:

- Proxy for bequest motive: available balance on the date of retirement;
- Proxy for irreversibility of decision: age at date of retirement;
- Proxy for necessity to liquidate: plan term, defined as number of years between commencement date of the pension plan and the date of retirement;
- Proxy for classification of prices: contractual technical premises.

Information available in the data is associated with regression variables as follows:

- Assuming that the available balance at retirement represents the level of wealth of the individual and that this level of wealth is indicative of the degree of altruism for this individual, it may be concluded that there is a predisposition to construct and preserve patrimony so that the individual’s heirs can benefit from these assets after his death. Given this assumption, it is expected that the coefficient of this variable has a negative sign, i.e., the higher the balance available at retirement, the lower the propensity of the individual to convert resources in retirement. This finding would corroborate studies by Fink and Redaelli (2004), who conclude that the higher the wealth of the individual, the greater the desire to leave an inheritance to his descendants.
- Assuming that advancing age is indicative of a reduction in survival time and that this reduction is strongly linked to an increased intertemporal discount rate (the notion that spending today is more important than saving today and spending tomorrow), it is reasonable to assume that the higher the age of the individual, the greater the weight of the irreversibility of the decision to convert. Given this assumption, it is expected that the coefficient of this variable has a negative sign, i.e., the higher the age of the individual, the lower his propensity to convert resources in retirement;

- Assuming that the period of resource accumulation in the complementary pension plan represents the individual's commitment to save and, consequently, to postpone consumption of those resources, it is feasible to assume that the longer the plan term, the less the individual's need for liquidity. Given this assumption, it is expected that the coefficient of this variable will have a positive sign, i.e., the longer the plan term, the higher the propensity of the individual to convert resources in retirement.
- The price of the complementary pension plan is based upon the contractual premises of the actuarial table and the interest rate. After classifying the database premises into favorable, reasonable and unfavorable, it could be assumed that the lower the price, the greater the desire of the individual to acquire the plan. Given this assumption, it is expected that individuals with access to favorable plans will have greater propensity to convert their resources in retirement than individuals with access to other plans. Similarly, individuals with access to reasonable plans will have greater propensity to convert their resources in retirement than individuals with access to unfavorable plans. Because the unfavorable premise was used to define the base scenario, it is expected that the coefficients of these variables will have positive signs with the value of the coefficient of the favorable premises greater than the coefficient of the reasonable premises.
- Considering that most pension plans marketed until 2007 were quoted based on the experience of male mortality, and given that life expectancy for females is greater than that of males, it is possible to assume that this advantage will motivate women to convert at a higher rate than men. Given this assumption and the fact that the base scenario was constructed with females, it is expected that the coefficient of this variable will have a negative sign, i.e., males are less prone to conversion than females.

The data for this study was obtained through the transfer of restricted data from the portfolio of a company with relevant activity in the Brazilian insurance market. The company's name is withheld owing to a confidentiality agreement with the authors of this paper. For ethical and strategic reasons, the company provided only the minimum amount of information deemed necessary for this study.

Included in the information provided are the following: a group of 14,511 individuals eligible for retirement in the period between January 1st, 2005 and December 31st, 2009; the balance of the mathematical provision of benefits to be paid on retirement date; retirement age; the term of each individual's plan; the classification of the

technical premises of the plan; the sex of the individual; the date of retirement and the individual's decision whether to convert or not convert resources in retirement. Additionally, the database was restricted to individuals with minimum accumulated reserves of R$3,500.00. The cutoff value was determined by observation of the available data to identify the lowest value of reserves converted in retirement during the period analyzed.

Table 2 contains the analysis of the model's main quantitative variables within the following groups: consolidated (converted and unconverted), converted (those who opted to convert resources in retirement) and unconverted (individuals who opted not to convert resources in retirement).

Table 2 - Descriptive Analysis of Variables by Conversion Decision

Statistics	Reserves (in R$)	Exit Age (in years)	Plan Term (in years)
Consolidated (n=14,511)			
Mean	96,172	63.31	4.49
Median	17,255	62.00	4.00
Standard deviation	567,865	11.59	3.97
Minimum	3,500	18.00	0.00
Maximum	35,025,094	99.00	25.00
Converted (n=668)			
Mean	268,901	60.85	4.17
Median	83,440	60.00	4.00
Standard deviation	519,940	10.35	4.41
Minimum	3,545	18.00	0.00
Maximum	6,047,627	95.00	24.00
Not Converted (n=13,843)			
Mean	87,837	63.43	4.51
Median	16,454	62.00	4.00
Standard deviation	568,768	11.63	3.95
Minimum	3,500	18.00	0.00
Maximum	35,025,094	99.00	25.00

Source: Developed by the authors.
Table 2 shows the main statistical measures of reserves data, exit age and plan term from the consolidated database; data is consolidated and segregated by decision group (converted versus not converted).

Analyzing the main descriptive measures of the two study groups, it can be observed that the average reserves of the group of individuals who converted resources in retirement (R$268.9 thousand) is higher than the average reserves of the group of individuals who did not convert (R$87.8 thousand). Given the wide dispersion range of the variable "reserves", it

was necessary to make a monotonic transformation. Thus, the Probit and Logit model parameters were estimated using the natural logarithm of this variable.

The variable "exit age" is normally distributed, assuming 18 years minimum value, 99 years maximum, mean and median of 62 and 63 years, respectively, and standard deviation of 11.59 years. Even when segregated into converted and not converted groups, these figures do not differ greatly.

The variable "plan term" assumes values between 0 and 25 years, with mean and median around 4 years and standard deviation of 3.97 years. The same pattern of behavior mentioned in the analysis of the variable "exit age" is seen here, i.e., no major differences are seen when the data are segregated into the converted and not converted groups.

Table 3 shows the proportion of individuals who opted to convert resources in retirement versus the proportion of individuals who opted to not convert these resources, presumably due to their personal characteristics or the characteristics of their plans. It can be seen that in all cases the percentage of individuals who chose not to convert resources is much higher than the percentage of individuals who opted for conversion, as has been observed and recorded in the literature.

Table 3 - Descriptive Analysis of Qualitative Variables Separated by Conversion Decision

Qualitative Variables	Converted	Not Converted
Favorable Premises - D1	8.59%	91.41%
Reasonable Premises - D2	12.50%	87.50%
Unfavorable Premises - Baseline	3.20%	96.80%
Male Sex - D3	4.45%	95.55%
Female Sex - Baseline	4.97%	95.03%

Source: Developed by the authors.
Table 3 shows, for each qualitative variable in the database, the percentage of individuals who converted and who did not convert resources in retirement.

Regarding plan features, it can be seen that the scenario with the unfavorable premises has the lowest conversion ratio (3.20%). This may be associated with the individuals' perception that the plan has actuarially unfair prices. A higher conversion rate was expected for the favorable premises scenario than for the others, but in practice, there was a slightly higher level of conversion for the reasonable premises scenario (12.50%) than for the favorable (8.59%). It can also be observed that females had a conversion rate (4.97%), slightly higher than that of males (4.45%).

Table 4 shows data for the qualitative variables of the model by year of eligibility and decision to convert. It is possible to observe some variability in the number of individuals

eligible for retirement each year. This variability becomes greater in the converted group, which shows a minimum quantity of 70 individuals opting to convert in 2006 and a maximum quantity of 172 individuals opting to convert in 2007.

Table 4 - Distribution of Data by Year and by Qualitative Variable of the Model

Qualitative Variables	2005	2006	2007	2008	2009	Total
Consolidated						
Favorable Premises - D1	806	517	621	683	715	3,342
Reasonable Premises - D2	67	35	30	48	76	256
Unfavorable Premises - Baseline	1,562	1,883	2,017	2,735	2,716	10,913
Total	2,435	2,435	2,668	3,466	3,507	14,511
Male Sex - D3	1,791	1,628	1,862	2,428	2,477	10,186
Female Sex - Baseline	644	807	806	1,038	1,030	4,325
Total	2,435	2,435	2,668	3,466	3,507	14,511
Coverted						
Favorable Premises - D1	134	35	37	45	36	287
Reasonable Premises - D2	-	3	1	7	21	32
Unfavorable Premises - Baseline	11	32	134	94	78	349
Total	145	70	172	146	135	668
Male Sex - D3	120	38	101	97	97	453
Female Sex - Baseline	25	32	71	49	38	215
Total	145	70	172	146	135	668
Not Converted						
Favorable Premises - D1	672	482	584	638	679	3,055
Reasonable Premises - D2	67	32	29	41	55	224,000
Unfavorable Premises - baseline	1,551	1,851	1,883	2,641	2,638	10,564
Total	2,290	2,365	2,496	3,320	3,372	13,843
Male Sex - D3	1,671	1,590	1,761	2,331	2,380	9,733
Female Sex - Baseline	619	775	735	989	992	4,110
Total	2,290	2,365	2,496	3,320	3,372	13,843

Source: Developed by the authors.

Table 4 shows the distribution of data by year and by group decision (converted vs. not converted) for qualitative variables in the model.

Table 5 shows the variability of the conversion rate measured from 2005 to 2009.

Table 5 – Historical Conversion Rate for Qualitative Variables

Qualitative Variables	2005	2006	2007	2008	2009	Total
Favorable Premises - D1	16.63%	6.77%	5.96%	6.59%	5.03%	8.59%
Reasonable Premises - D2	0.00%	8.57%	3.33%	14.58%	27.63%	12.50%
Unfavorable Premises - Baseline	0.70%	1.70%	6.64%	3.44%	2.87%	3.20%
Male Sex - D3	6.70%	2.33%	5.42%	4.00%	3.92%	4.45%
Female Sex - Baseline	3.88%	3.97%	8.81%	4.72%	3.69%	4.97%
Total	5.95%	2.87%	6.45%	4.21%	3.85%	4.60%

Source: Developed by the authors.

Table 5 shows the conversion rate observed each year in the database for qualitative variables in the model.

4. Results

Table 6 shows the estimated parameters for the Probit model. All the study variables, except the dummies for years 2006 and 2009, were statistically relevant at 5%.

The positive sign of the coefficient of the variable "ln(Reserves)" indicates that the higher the value of reserves the greater the propensity of the individual to convert resources. This contradicts the expected result for this variable. A possible explanation for this result is described in Bütler and Teppa (2007). According to the authors, a high intertemporal discount rate can mean not only lower accumulation of resources (reserves), but also a higher propensity for the individual to redeem resources only at the date of retirement.

Table 6 - Probit Model Results

Variable	Coefficient (Probit)	Standard Error	p-value
Constant	-3.987	0.1682	< 0.0001
ln(Reserves)	0.2873	0.0115	< 0.0001
Exit Age	-0.0101	0.0019	< 0.0001
Plan Term	-0.0383	0.007	< 0.0001
D1 - Favorable Premises	0.6065	0.0576	< 0.0001
D2 - Reasonable Premises	0.4506	0.1059	< 0.0001
D3 - Male Sex	-0.3115	0.0446	< 0.0001
D4 - Year 2006	-0.128	0.0701	0.0679
D5 - Year 2007	0.3842	0.0581	< 0.0001
D6 - Year 2008	0.1249	0.0595	0.0356
D7 - Year 2009	0.0013	0.0627	0.9841
R-squared	0.1577		

Source: Developed by the authors.
Table 6 shows the main results found in the Probit model. The cutoff value given in this work for assessing the significance of variables was 0.05. The qualitative variables, "price classification," "sex" and "year" were modeled as dummy variables. The baseline scenario for these variables is: unfair prices (unfavorable technical premises), female sex and year of retirement in 2005.

The negative sign for the coefficient of the exit age variable conforms to the expected result and indicates that the greater the age of the individual, the lower his propensity to convert resources in retirement. This decision may be justified by the greater proximity to death and, consequently, by a desire to spend more today rather than save to spend tomorrow.

The negative sign for the coefficient of the variable representing plan term indicates that the longer the plan term, the lower the propensity of the individual to convert resources in retirement. This result also contradicts the expected result. It is possible that this divergence is a reflection of the individual's changing need for liquidity during retirement as compared with his employment period. However, this hypothesis needs confirmation through further empirical studies.

The positive sign for the coefficients of favorable and reasonable premises suggests that the more favorable the premise, the greater the propensity of the individual to convert resources in retirement. Given the lack of interest in conversion noted in the population with unfavorable plans, it can be said that this factor is significant in the investor's decision-making at the time of retirement.

Because the baseline scenario was constructed with females, with a negative sign for the coefficient representing males, it is possible to infer that males have a lower propensity to convert resources in retirement than females. The result found is consistent with the expected result. Females are offered an opportunity by cheaper pricing that does not accurately reflect their life expectancy.

All the dummy years except 2009 are statistically significant (with a significance level of 10%). An alternative model was estimated where the dummy years are replaced by the basic interest rate (SELIC). Although the R^2 obtained cannot be directly comparable (given the different number of explanatory variables), it may be deduced that dummy years capture the economic effect associated with current interest rates upon retirement.

Finally, an observation about the calibration of the model is appropriate. Table 7 shows the percentage of correct classification for each of the possible scenarios (y=0 and y=1), given a cutoff value of 0.5, as indicated in the literature.

Table 7 - Percentage of Correct Classification

	Model			
Real		Converted	Not converted	Total
	Converted	6	662	668
	Not converted	7	13,836	13,843
	Total	13	14,498	14,511
Percentage of correct classification		0.90%	99.95%	95.39%

Source: Developed by the authors.
Table 7 shows the percentage of correct classification for the model given the cutoff value of 0.5 as suggested in the literature.

Through the analysis of Table 7, it can be seen that the model is not adequate to predict the number of individuals with a propensity to convert. According to the model, only six individuals would opt for the conversion of resources, while in reality 668 opted for conversion. The percentage correctly predicted for this scenario was 0.90%, while for the non-conversion scenario the percentage correctly predicted was 99.95%.

Usually, a pension institution is interested in estimating the number of individuals with a propensity to convert and not vice versa. Thus, it is valid to adopt a calibration model that assigns a cutoff value that improves the predictability of the desired scenario. This model improves the predictability of the scenario in which the response variable is 1 but reduces the predictability of the scenario in which the response variable is 0. This trade-off must be carefully evaluated by the person responsible for administering the study, and strategy (bold, neutral or conservative) should be in line with the policies of the company or business.

Table 8 is included to illustrate the results when a new calibration model was adopted with a cutoff value of 0.07 instead of the 0.5 suggested by the literature. The choice of cutoff value of 0.07 was *ad hoc*, its purpose simply to illustrate the result of a change in criterion.

Table 8 - Percentage of Correct Classification (recalibrated model)

	Model			
Real		Converted	Not converted	Total
	Converted	382	286	668
	Not converted	2,262	11,581	13,843
	Total	2,644	11,867	14,511
Percentage of correct classification		57.19%	83.66%	82.44%

Source: Developed by the authors.
Table 8 shows the percentage of correct classification of the model given the arbitrary cut-off value of 0.07.

This model would correctly estimate 57.19% of individuals who have opted for the conversion of resources and 83.66% of individuals who chose not to convert.

Table 9 shows the estimated parameters for the Logit model. An additional advantage of this model is the possibility of estimating marginal effects, based on the results. Thus:

- An increase of 1% in reserves, *ceteris paribus*, increases the chance of conversion of resources into income by 0.57%;
- An increase of one year in the exit age of the individual, *ceteris paribus*, reduces the chance of conversion of resources into income by 2.16%;
- An increase of one year in the term of an individual's plan, *ceteris paribus*, reduces the chance of conversion of resources into income by 8.63%;
- The individual’s access to a plan quoted with favorable premises compared to a plan with unfavorable premises, *ceteris paribus*, increases the chance of converting resources into income by 295%.

- The individual's access to a plan quoted with reasonable premises as compared to a plan with unfavorable premises, *ceteris paribus*, increases the chance of conversion of resources into income by 177%.
- The fact that an individual is male as compared to female, *ceteris paribus*, reduces the chance of converting resources into income by 50.76%.

Table 9 - Logit Model Results

Variable	Coefficient (Logit)	Standard Error	p-value	Variation (%) in the chance of conversion for increase of one unit of variable
Constant	-74.120	0.3610	< 0.0001	
ln(Reserves)	0.5652	0.0225	< 0.0001	
Reserves				0.567
Exit age	-0.0219	0.0043	< 0.0001	-2.165
Plan Term	-0.0903	0.0146	< 0.0001	-8.632
D1 - Favorable Premises	13.740	0.1147	< 0.0001	295.190
D2 - Reasonable Premises	10.180	0.1998	< 0.0001	176.992
D3 - Male Sex	-0.7085	0.0951	< 0.0001	-507.630
D4 - Year 2006	-0.2853	0.1522	0.0608	-248.180
D5 - Year 2007	0.6896	0.1195	< 0.0001	992.990
D6 - Year 2008	0.2323	0.1236	0.0601	26.155
D7 - Year 2009	-0.0229	0.1315	0.8619	-2.260
R-squared	0.158451			

Source: Developed by the authors.

Table 9 shows the main findings of the Logit model and the marginal effect of each variable in the model. The qualitative variables, "price classification," "sex" and "year," were modeled as dummy variables. The baseline scenario for these variables is: unfair prices (unfavorable technical premises), female sex and year of retirement in 2005.

5. Conclusion

For decades, the Brazilian insurance market has sold complementary pension plans with outdated technical premises. Insurers have had to make available sufficient additional resources to cover eventual deficits, guaranteeing to participants and to the regulatory body that they are creditworthy and can meet their obligations towards payment of benefits.

Allocating the resources needed to meet this provision is the responsibility of insurers; so that participants and beneficiaries are fully guarded against any imbalance generated by the way these plans were marketed. It is, therefore, vital to estimate as accurately as possible the inputs of the model used to calculate this provision.

It could be argued that a simple time series model would be able to accurately estimate future conversion rates using conversion rates observed in the past. However, the high volatility shown in the series and the lack of correlation between conversion rates over time render it almost impossible to use traditional time series models (ARMA-GARCH family). Thus, this work intended to present a structural model for determining the conversion rate of resources, taking into account the relative influence of each of the factors listed in the literature upon the decision-making process at the time of retirement.

Analyzing the influence of the characteristics for each individual in the database indicates that both the volume of accumulated reserves and the classification of prices as actuarially fair increase the propensity of individuals to convert resources in retirement. In turn, the retirement age and the need for liquidity reduce the propensity to convert resources. Additionally, the study revealed that males tend to have a lower conversion rate than females.

The above results are of great importance to insurers because they clearly demonstrate the marginal impact of statistically significant explanatory variables. The model shown can be reproduced relatively easily and enhanced with other defining characteristics to help identify the individuals with a high propensity to convert resources in retirement. This flexibility makes it an even more important tool for the process of calculating the eventual deficit associated with a benefit plan.

It should be noted that enhancing the analysis presupposes the existence of additional information from the institution, which calls for the generation of additional data about individuals: income level, marital status or number of dependents, for example.

Future research could examine the findings for the coefficients of the variables "volume of reserves" and "plan term", which contradicted the expected results.

References

BERNHEIM, D. How strong are bequest motives? Evidence based on estimates of the demand for life insurance and annuities. *The Journal of Political Economy*, v. 99, p. 899-927, 1991.

BÜTLER, M.; TEPPA, F. The choice between an annuity and a lump sum: results from Swiss pension funds. *Journal of Public Economics*, v. 91, p. 1944-1966, 2007.

DAVIDOFF, T.; BROWN, J.; DIAMOND, P. Annuities and individual welfare. *The American Economic Review*, v. 95, p. 1573-1590, 2005.

DUS, I.; MAURER, R.; MITCHELL, O. Betting on death and capital markets in retirement: a shortfall risk analysis of life annuities versus phased withdrawal plans. *Financial Services Review,* v. 14, p. 169-196, 2005.

FINK, G.; REDAELLI, S. Understanding bequest motives – An empirical analysis of intergenerational transfers, *DNB Working Paper*, n. 42, 2004.

HEIJ, C.; DE BOER, P.; FRANSES, P.; KLOEK, T.; VAN DIJK,H. *Econometric methods with applications in business and economics*, Oxford University Press, 2004.

HORNEFF, W.J.; MAURER, R.H.; MITCHELL, O. S.; STAMOS, M.Z. Variable payout annuities and dynamic portfolio choice in retirement, *Journal of Pension Economics and Finance*, v.9, p. 163-183, 2010.

MELIA, C.V.; GARCÍA, A.L. Demand for life annuities from married couples with a bequest motive, *Journal of Pension Economics and Finance*, v.5, p. 197-229, 2006.

MILEVSKY, M.; YOUNG, V. Optimal asset allocation and the real option to delay annuitization: it's not now-or-never. Version: 13 April 2002. http://www.ifid.ca/research.htm Accessed on 17/10/2010.

PURCAL, S.; PIGGOT, J. Explaining low annuity demand: an optimal portfolio application to Japan. *The Journal of Risk and Insurance*, v.75, p. 493-516, 2008.

WOOLDRIDGE, J. *Introductory Econometrics: A Modern Approach*, 4. ed. Mason: Thomson - South-Western, 2009.

YAARI, E. Uncertain lifetime, life insurance, and the theory of the consumer. *The Review of Economic Studies*, v. 32, p. 137-150, 1965.